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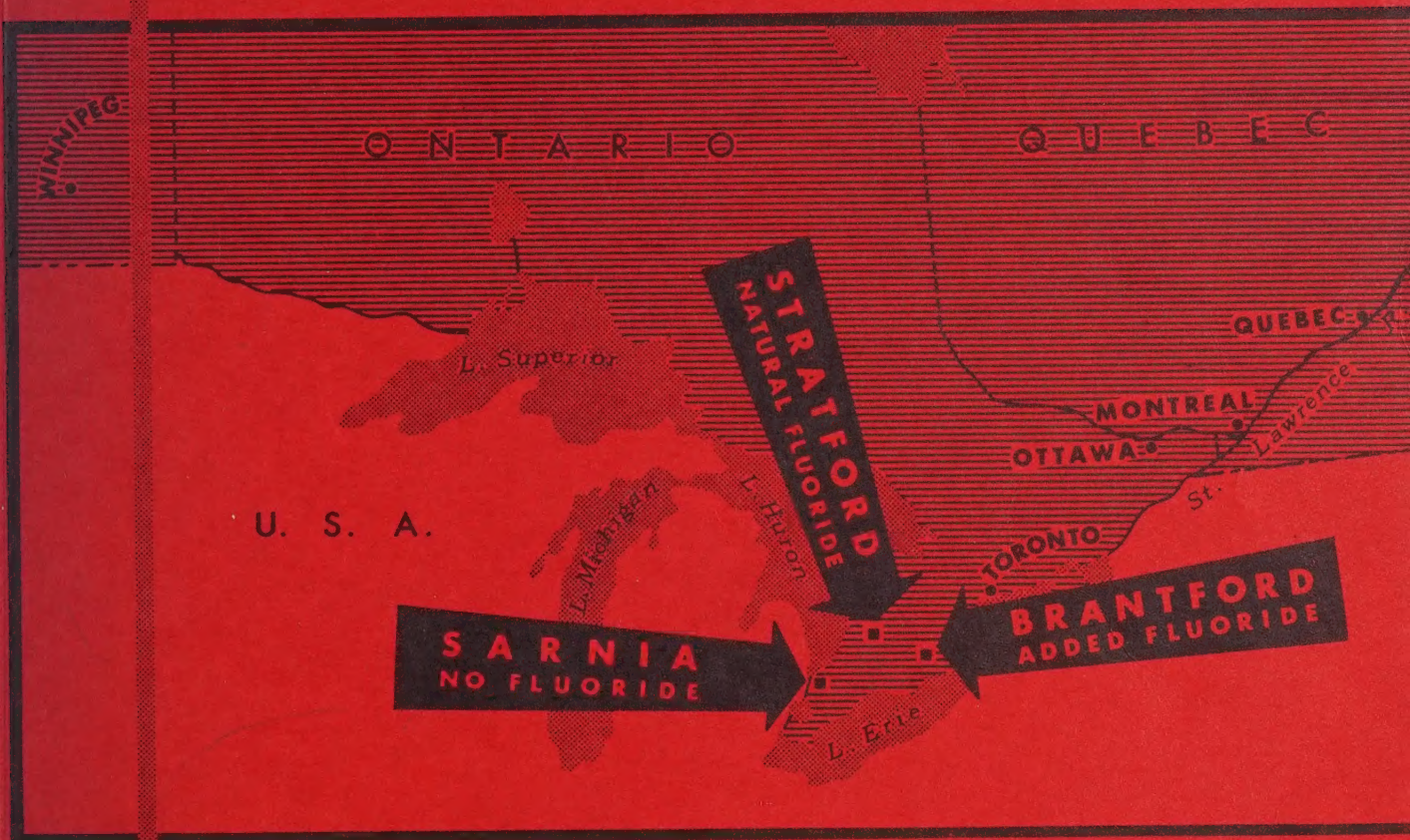
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dental
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Fluoridation



1957 REPORT

MASS CONTROL OF DENTAL CARIES BY FLUORIDATION
OF A PUBLIC WATER SUPPLY

PREFACE

DENTAL EFFECTS OF WATER FLUORIDATION

Sixth Report

on

The Brantford Fluoridation Caries Study

This report is designed to present an analysis and a comparison of the caries data from the first survey (1948), and the latest survey, 1957.

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Dental Health Division
Department of National Health and Welfare

Ottawa

August, 1958

REPORT OF THE COMMISSIONER OF THE GENERAL LAND OFFICE

OF A LANDS AND WATER DISTRICT

IN THE DISTRICT OF COLUMBIA



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THE DISTRICT OF COLUMBIA

REPORT OF THE COMMISSIONER OF THE GENERAL LAND OFFICE
OF A LANDS AND WATER DISTRICT
IN THE DISTRICT OF COLUMBIA

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PREFACE

On June 20th, 1957, Brantford, Ontario had completed twelve years of successful experience with a mechanically fluoridated water supply.

The report presented in the following pages will show the tooth decay experience of native children of Brantford, Stratford and of Sarnia, Ontario from 1948 to 1957.

This report has been prepared by H.K. Brown, D.D.S., D.D.P.H., Dental Consultant, Department of National Health and Welfare, with the assistance of Hugh R. McLaren, D.D.S., D.D.P.H., Dental Health Division, G.H. Josie, M.Sc., and Barbara J. Stewart, B.A. of the Research and Statistics Division of the Department of National Health and Welfare.

INTRODUCTION

On June 20th, 1957, Dr. J. H. McArthur, Ontario had completed twelve years of successful experience with a mechanical fluorinated resin supply.

The report presented in the following pages will show the results of the experience of native children of Ontario, Ontario and of Ontario, Ontario from 1948 to 1957.

This report has been prepared by H. K. Brown, D.D.S., D.D.P.H., Dental Consultant, Department of National Health and Welfare, with the assistance of Hugh A. McArthur, D.D.S., D.D.P.H., Dental Health Division, H. K. Lewis, M.Sc., and Barbara J. Stewart, B.A., of the Research and Statistics Division of the Department of National Health and Welfare.

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FIG. I
DMF PERMANENT TEETH PER CHILD
SARNIA, BRANTFORD & STRATFORD 1948-1957

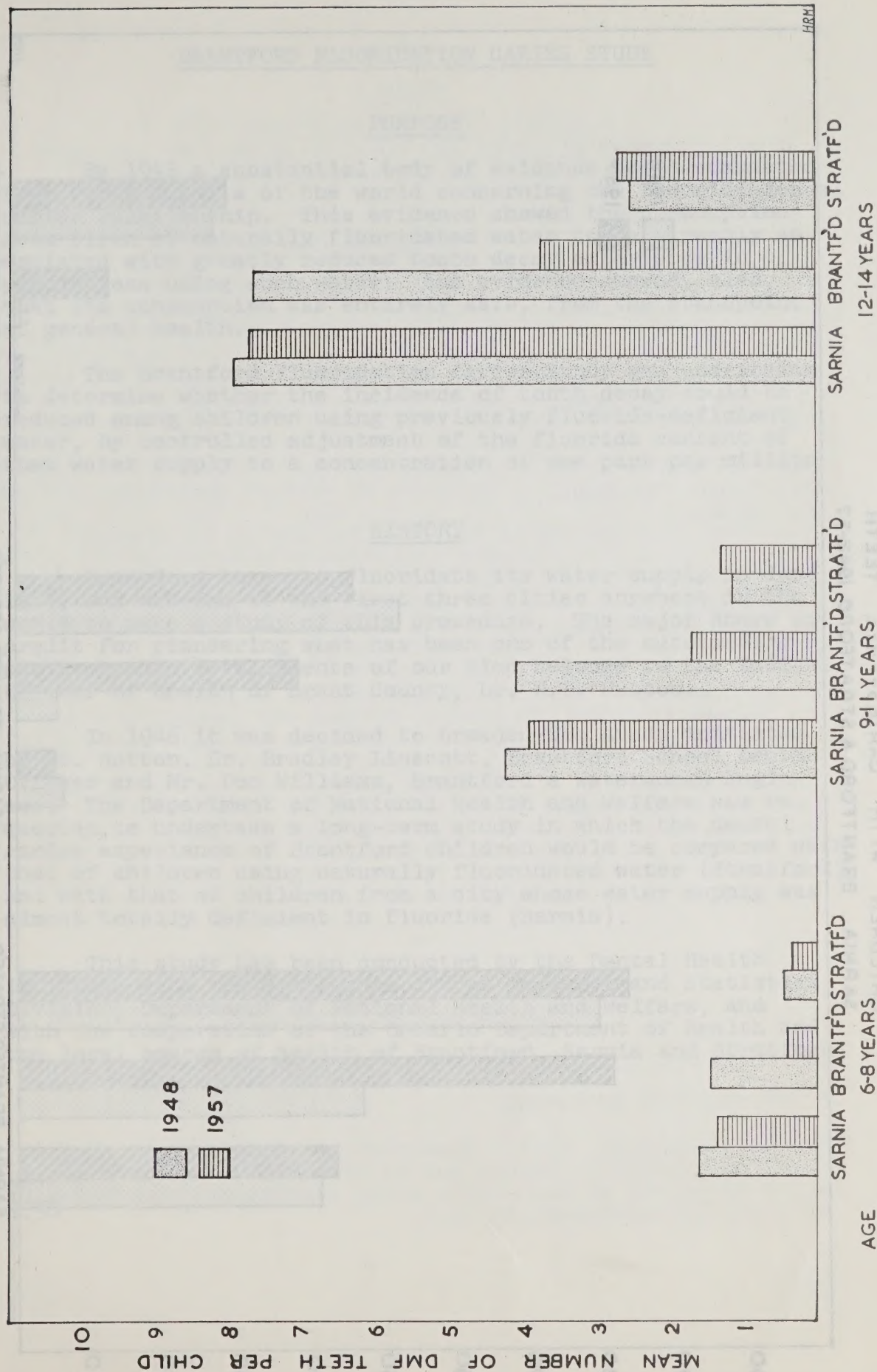
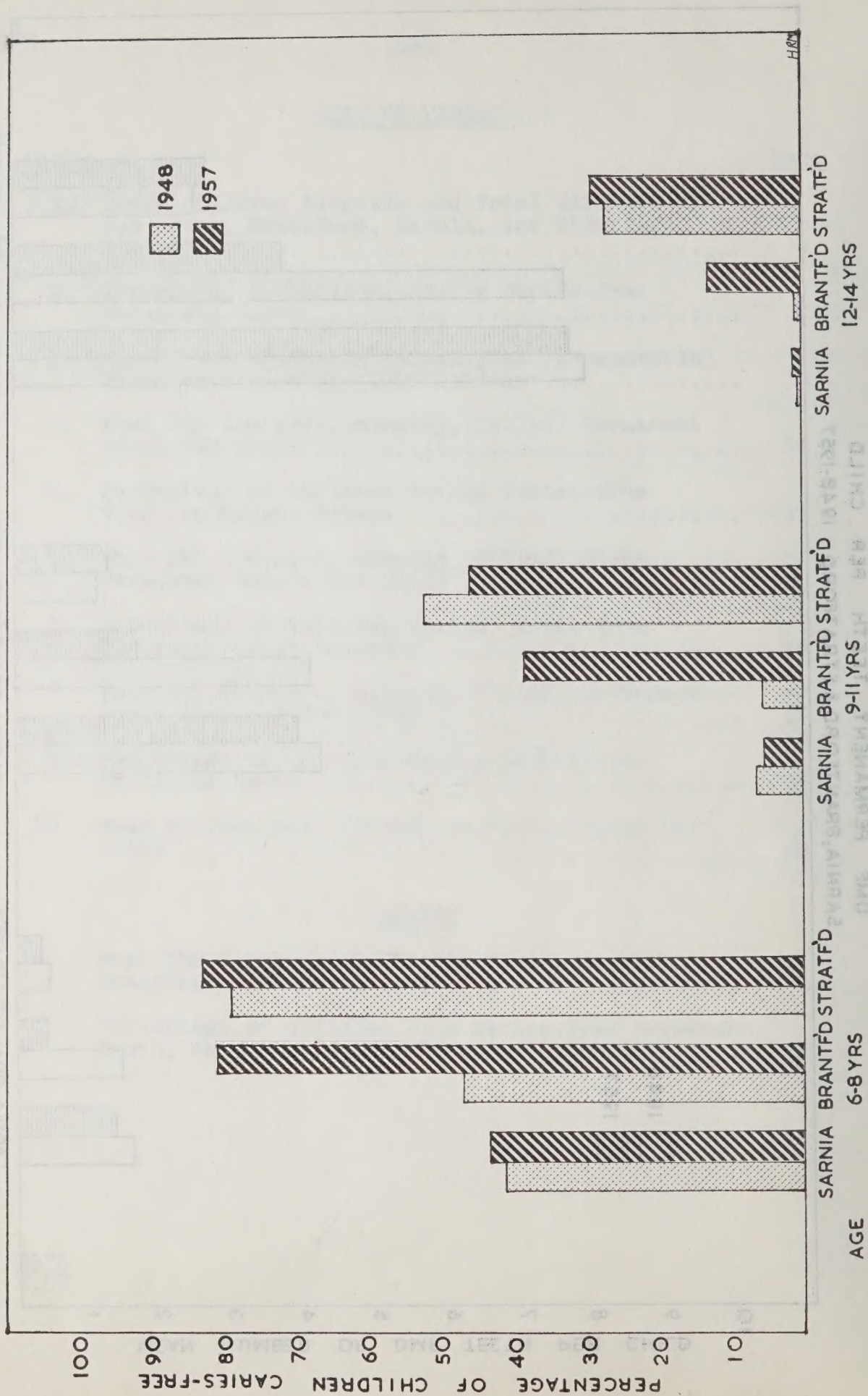


FIG. II
CHILDREN WITH CARIES-FREE TEETH
SARNIA BRANTFORD & STRATFORD 1948-57



BRANTFORD FLUORIDATION CARIES STUDY

PURPOSE

By 1945 a substantial body of evidence has accumulated from various parts of the world concerning the fluoride-dental caries relationship. This evidence showed the consumption from birth of naturally fluoridated water to be directly associated with greatly reduced tooth decay experience in populations using such water: the evidence showed, also, that its consumption was entirely safe, from the standpoint of general health.

The Brantford Fluoridation Caries Study was undertaken to determine whether the incidence of tooth decay could be reduced among children using previously fluoride-deficient water, by controlled adjustment of the fluoride content of that water supply to a concentration of one part per million.

HISTORY

Brantford began to fluoridate its water supply in June, 1945, and was one of the first three cities anywhere in the world to make a study of this procedure. The major share of credit for pioneering what has been one of the outstanding public health developments of our time belongs to the Medical Officer of Health of Brant County, Dr. W.L. Hutton.

In 1946 it was decided to broaden the study initiated by Dr. Hutton, Dr. Bradley Linscott, Brantford School Dental Officer and Mr. Don Williams, Brantford's Waterworks Engineer. The Department of National Health and Welfare was requested to undertake a long-term study in which the dental caries experience of Brantford children would be compared with that of children using naturally fluoridated water (Stratford) and with that of children from a city whose water supply was almost totally deficient in fluoride (Sarnia).

This study has been conducted by the Dental Health Division, with the assistance of the Research and Statistics Division, Department of National Health and Welfare, and with the cooperation of the Ontario Department of Health and the local boards of health of Brantford, Sarnia and Stratford.

TABLE 1

TOTAL CHILDREN ELIGIBLE AND TOTAL EXAMINED, BY AGE GROUP
Brantford, Sarnia and Stratford, 1948 and 1957

<u>1948</u>	<u>Age Group</u>	<u>Sarnia</u>	<u>Brantford</u>	<u>Stratford</u>
Total Eligible	6-8	677	963	511
No. Chosen for Exam.		*	624	*
No. Examined		669	619	505
Total Eligible	9-11	580	816	434
No. Chosen for Exam.		*	602	*
No. Examined		571	595	432
Total Eligible	12-14	495	747	376
No. Chosen for Exam.		*	600	*
No. Examined		486	593	371
<u>1957</u>				
Total Eligible	6-8	782	1526	797
No. Chosen for Exam.		520	505	500
No. Examined		501	919	482
Total Eligible	9-11	866	1221	690
No. Chosen for Exam.		520	522	493
No. Examined		512	642	471
Total Eligible	12-14	630	937	490
No. Chosen for Exam.		525	535	*
No. Examined		511	381	459

* No sampling performed.

Census population, 1951: Brantford, 36,727; Sarnia, 34,697; Stratford, 18,785. Sarnia survey area includes Point Edward which is served by the Sarnia water supply, but not other outlying areas annexed in 1953.

SELECTION OF STUDY SAMPLES

Within the age groups 6-8, 9-11 and 12-14 years, the total of children in each city who are eligible for inclusion in the study is determined on the basis of 'continuous' residence, where 'continuous' residence is defined as including absences, since birth, of six weeks or less. Thus the study compares a group of children (Brantford) who have used a mechanically fluoridated water supply continuously since June 1945, and who before that date did not use fluoridated water, with a group (Sarnia) who continuously since birth have not used fluoridated water, and a second group (Stratford) who have used continuously since birth water fluoridated from underground deposits of fluoride. For the individual children, residence eligibility is determined from information supplied by the parents. All schools of each city are canvassed, secondary as well as primary.

Inspection of available caries incidence data indicated that, for purposes of statistical adequacy, at least 500 children in each age group in each city should be examined. Where the total number of eligible children in any age group warranted it, the study sample was drawn out by a process of random sampling in the manner described in "A Suggested Methodology for Fluoridation Surveys in Canada". (1) Table 1, page 4, shows for the years 1948 and 1957 the totals of eligible children, the numbers chosen for examination and the numbers actually examined. A clerical error in the sampling of the Brantford age groups in 1957, while not affecting the randomness of the sample, resulted in larger numbers being examined at ages 6-8 and 9-11 years than were required for statistical accuracy. The total number of Brantford children in the 12-14 age group in the same year, fell below the desired limit, which resulted in some loss of precision in the statistical significance of differences in the data concerning this age group.

METHOD OF EXAMINING AND RECORDING

With a view to maintaining as uniform a scale of observation as possible throughout the study, all examinations have been done by the same examiner, using a portable examining light of specific intensity kept at a constant distance, plane mouth mirrors and No. 5 Clev-dent explorers. The lowest limit in size for a caries lesion was defined as one in which the point of the explorer would stick and resist direct withdrawal, or in which softness could be felt. Hard discoloured enamel surfaces and enamel imperfections were not recorded as caries. Any observable mottling was recorded. Oral hygiene was also recorded and classified as 'good', 'fair', 'poor'.

A chart depicting all the coronal surfaces of both permanent and primary teeth was used for recording. Although this report presents data only for DMF (decayed, missing and filled) permanent teeth and df (decayed and filled) primary teeth, tooth decay was recorded in the detail necessary for analysis by the number of surfaces affected. In addition every tooth space was accounted for in order that later analysis might be made in terms of a DMF tooth record of all erupted teeth per child.

FINDINGS

The data presented in this report show the extent of change in the occurrence of dental caries among Brantford children between 1948 and 1957. Data for intervening surveys have been summarized in a previous report (2).

The 1957 study-findings are presented, as was the case in earlier reports, with respect to (1) all permanent teeth, (2) first permanent molars, (3) permanent upper incisors, (4) primary teeth. The indices used to measure caries-prevalence are (a) percentage of children having caries-free teeth, (b) tooth mortality rate, (c) mean DMF permanent teeth, (d) mean df primary teeth.

The findings concerning Brantford children, where the fluoride-content of the water supply has been adjusted to a concentration of 1.2 ppm since June 1945, are shown in comparison with caries-prevalence data among Sarnia children, whose water-supply is deficient in fluorides, and with similar data concerning children in Stratford, Ontario, where the natural fluoride-content of the water supply has been 1.6 ppm for more than forty years.

TABLE 2

PERCENTAGE OF CHILDREN HAVING CARIES-FREE PERMANENT TEETH

AGE GROUP	YEAR	Percentage of Children having Caries-free Permanent Teeth and Standard Error of Percentage					
		SARNIA		BRANTFORD		STRATFORD	
6-8	1948 1957	40.96 $\pm$ 1.901 43.51 $\pm$ 2.215		46.69 $\pm$ 2.005 80.85 $\pm$ 1.298		78.42 $\pm$ 1.831 83.09 $\pm$ 1.702	
9-11	1948 1957	6.13 $\pm$ 1.001 5.66 $\pm$ 1.022		5.71 $\pm$ 0.950 38.47 $\pm$ 1.920		52.08 $\pm$ 2.404 45.96 $\pm$ 2.299	
12-14	1948 1957	0.62 $\pm$ 0.350 1.37 $\pm$ 0.514		1.18 $\pm$ 0.447 13.39 $\pm$ 1.744		27.22 $\pm$ 2.310 29.39 $\pm$ 2.133	
Differences in Percentage of Children having Caries-free Permanent Teeth							
AGE GROUP	YEAR	INTER-CITY		YEARS	INTER-YEAR		
		SARNIA BRANTFORD	BRANTFORD STRATFORD		SARNIA	BRANTFORD	STRATFORD
6-8	1948 1957	5.73 S 37.34 SS	31.73 SS 2.24 NS	1948-57	2.55 NS	34.16 SS	4.67 NS
9-11	1948 1957	-0.42 NS 32.81 SS	46.37 SS 7.49 S	1948-57	-0.47 NS	32.76 SS	-6.12 NS
12-14	1948 1957	0.56 NS 12.02 SS	26.04 SS 16.00 SS	1948-57	0.75 NS	12.21 SS	2.17 NS

For levels of statistical significance, and discussion of standard error, see page 23.

Percentage of Children Having Caries-Free Permanent Teeth

The findings concerning the percentage of children in Sarnia, Brantford and Stratford who were found to be caries-free, with respect to permanent teeth, in 1948 and 1957 are summarized in Table 2.

At all ages studied, there has been a significant increase in the percentages of Brantford children having caries-free permanent teeth between 1948 and 1957. Among Sarnia children, and Stratford children, however, no significant differences were observed between the 1948 and 1957 findings. In 1948 caries prevalence, in terms of this characteristic, was of the same order among Brantford and Sarnia children. Significantly lower percentages of caries-free children were found, on the other hand, in Brantford than in Stratford, in all three age-groups.

Between 1948 and 1957, highly significant increases in the percentages of caries-free children have been observed in all three age-groups studied in Brantford, as compared with Sarnia. The Sarnia-Brantford differences, in this regard, were first observed in 1951, and have increased in magnitude, in favor of the Brantford children, from year to year since then. The magnitude of the Brantford-Stratford differences, while still in favor of Stratford children in 1957 (except for the 6-8 years age-group) has decreased substantially in the case of all three age-groups, since 1948. The 1957 study-findings show no significant difference between percentages of caries-free children, at ages 6-8 years, in these two cities. This has been found to be the case since 1954.

Mean Tooth Mortality

The end-result of caries-attack, in the absence of timely dental care, is tooth loss. There is a direct correlation between tooth mortality rates, i.e., the numbers of teeth extracted and/or indicated for extraction per 100 children, and caries prevalence rates, in terms of the numbers of teeth attacked by caries per 100 children. Any measure, therefore, which operates to reduce the occurrence of dental caries among children should be reflected in lower tooth mortality. Table 3 summarizes the findings, in this regard, among children in Sarnia, Brantford, and Stratford, between 1948 and 1957.

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8.58

TABLE 3

MEAN TOOTH MORTALITY (MISSING AND IRREPARABLE) PERMANENT TEETH PER 100 CHILDREN

AGE GROUP	YEAR	Mean Tooth Mortality (Missing and Irreparable Permanent Teeth) per 100 Children and Standard Error of Mean					
		SARNIA		BRANTFORD		STRATFORD	
6-8	1948	7.03	± 1.367	1.62	± 0.641	0.99	± 0.441
	1957	7.98	± 1.881	1.20	± 0.420	1.44	± 0.742
9-11	1948	51.31	± 4.348	28.91	± 3.016	5.09	± 1.445
	1957	35.74	± 3.749	5.76	± 1.152	11.28	± 2.225
12-14	1948	137.24	± 7.985	84.32	± 5.602	18.87	± 2.911
	1957	97.46	± 6.948	26.51	± 3.572	21.27	± 3.046
Differences in Mean Tooth Mortality (Missing and Irreparable Permanent Teeth) per 100 Children							
AGE GROUP	YEAR	INTER-CITY		INTER-YEAR			
		SARNIA BRANTFORD	BRANTFORD STRATFORD	YEARS	SARNIA	BRANTFORD	STRATFORD
6-8	1948	-5.41 SS	-0.63 NS	1948-57	0.95 NS	-0.42 NS	0.45 NS
	1957	-6.78 SS	0.24 NS				
9-11	1948	-22.40 SS	-23.82 SS	1948-57	-15.57 S	-23.15 SS	6.19 S
	1957	-29.98 SS	5.52 S				
12-14	1948	-52.92 SS	-65.45 SS	1948-57	-39.78 SS	-57.81 SS	2.40 NS
	1957	-70.95 SS	-5.24 NS				

For levels of statistical significance, and discussion of standard error, see page 23.

In 1948, following three years' use of fluoridated water, caries prevalence among Brantford children and among Sarnia children was found still to be of the same order. Tooth mortality among Brantford children, however, was significantly lower at all ages studied than was observed in the case of Sarnia children. It was observed, also, that a much higher ratio between treated and untreated carious defects was exhibited by children in the former city; this factor was considered to be chiefly responsible for the more favourable conditions of tooth mortality among Brantford children. In comparison with Stratford children, in 1948, caries was four times as prevalent among Brantford children. No significant difference in tooth mortality was found between Brantford and Stratford children, aged 6-8 years, but, among Brantford children aged 9-11 years, and 12-14 years, tooth mortality was significantly higher than among Stratford children at these ages.

By 1957, tooth mortality had decreased significantly in comparison with 1948 levels, among the two older age-groups in Brantford. During the same period, a decrease occurred also, in this regard, among Sarnia children aged 9-11 years and 12-14 years; little change was observed, in the case of Stratford children between 1948-1957, save for an increase of borderline significance in tooth mortality among that city's children, aged 9-11 years.

Comparison of the inter-city differences in tooth mortality, in 1957 (Table 3) shows that a striking and significant decrease in this characteristic has taken place between 1948 and 1957, in favor of Brantford children in all three age-groups. During the same period, tooth mortality among Brantford children has decreased to the point where no significant differences exist between Brantford and Stratford children aged 6-8 years and 12-14 years. Between 9-11 years old children in these two cities, in 1957, a difference, having borderline significance was observed in favor of Brantford children.

Mean DMF Teeth

The effectiveness of a community-wide preventive measure against dental caries should be reflected not only in a decrease in the numbers of persons affected by the disease, but also in a lowering of the caries attack-rate, i.e., the numbers of teeth becoming carious, per person. Table 4 summarizes the findings with respect to caries attack-rates among children in Sarnia, Brantford and Stratford in 1948 and in 1957.

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8.58

TABLE 4

MEAN DMF (DECAYED, MISSING, FILLED) PERMANENT TEETH PER CHILD

AGE GROUP	YEAR	Mean DMF Permanent Teeth Per Child and Standard Error of Mean			
		SARNIA	BRANTFORD	STRATFORD	
6-8	1948	1.60 ± 0.064	1.41 ± 0.064	0.41 ± 0.040	
	1957	1.34 ± 0.067	0.40 ± 0.031	0.32 ± 0.037	
9-11	1948	4.21 ± 0.114	4.07 ± 0.093	1.13 ± 0.072	
	1957	3.92 ± 0.111	1.71 ± 0.067	1.30 ± 0.069	
12-14	1948	7.94 ± 0.200	7.68 ± 0.164	2.55 ± 0.130	
	1957	7.75 ± 0.176	3.78 ± 0.142	2.70 ± 0.121	
Differences in Mean DMF Permanent Teeth Per Child					
AGE GROUP	YEAR	INTER-CITY		INTER-YEAR	
		SARNIA BRANTFORD	BRANTFORD STRATFORD	YEARS	SARNIA BRANTFORD
6-8	1948	-0.19 S	-1.00 SS	1948-57	-1.01 SS
	1957	-0.94 SS	-0.08 NS		-0.09 NS
9-11	1948	-0.14 NS	-2.94 SS	1948-57	-2.36 SS
	1957	-2.21 SS	-0.41 SS		-0.17 NS
12-14	1948	-0.26 NS	-5.13 SS	1948-57	-3.90 SS
	1957	-3.97 SS	-1.08 SS		0.15 NS

For levels of statistical significance, and discussion of standard error, see page 23.

In 1948, Sarnia-Brantford differences in caries attack-rates, expressed as mean numbers of decayed, missing and/or filled permanent teeth per child, were slight. Except for children in the 6-8 year group, where this difference favored Brantford children, caries attack-rates were found not to be significantly different between Brantford and ~~Stratford~~ ^{Sarnia} children. In the same year, however, markedly significant differences were observed, in favor of Stratford children, all of whom had had lifetime experience of the use of naturally fluoridated water.

Between 1948 and 1957 a marked and significant decline has occurred in caries attack-rates among Brantford children, at all ages studied. Children of all ages being considered together, the reduction in the numbers of DMF teeth in 1957, in relation to 1948 levels, amounts to 73.5%.

Comparison of the inter-year differences for both Sarnia and Stratford children shows that in all three age-groups, caries attack-rates continues at about the same levels in 1957 as were observed in 1948, among children in both cities. The inter-year differences between Sarnia and Brantford children show a marked reduction between 1948 - 1957, in favor of Brantford children in all three age-groups under study. It should be noted that inspection of the current study-findings together with those which have been reported previously (2) indicates that the magnitude of the Sarnia-Brantford differences in caries attack-rates has continued to increase from year to year, ever since 1951.

In 1957, the Brantford-Stratford differences in this respect continues to be in favor of Stratford children, except for the 6-8 years age-groups. No significant differences were observed between Brantford and Stratford children of this age-group; the current findings re-confirm, in this respect, observations made in 1954 and in 1955. The differences in caries attack-rates between 9-11 and 12-14 year old children in Brantford and Stratford are of the same magnitude in 1957 as in 1955.

First Permanent Molars

Tables 5 and 6 summarize the findings in 1948 and 1957 of the dental caries experience of the first permanent molars only, of children in Sarnia, Brantford and Stratford. These data are presented separately because of the fact that the first permanent molars are the most highly susceptible to caries of all permanent teeth, and that, among children of the ages included in this study, caries attacks upon these

TABLE 5

First
PERCENTAGE OF CHILDREN HAVING CARIES-FREE/PERMANENT MOLARS

AGE GROUP	YEAR	Percentage of Children Having Caries-free First Permanent Molars and Standard Error of Percentage			
		SARNIA		BRANTFORD	
6-8	1948	41.26 ± 1.904		46.85 ± 2.006	78.42 ± 1.831
	1957	44.11 ± 2.218		81.07 ± 1.292	84.33 ± 1.651
9-11	1948	6.65 ± 1.046		6.22 ± 0.989	52.31 ± 2.403
	1957	6.45 ± 1.085		38.94 ± 1.925	47.45 ± 2.303
12-14	1948	1.03 ± 0.451		2.02 ± 0.575	33.69 ± 2.454
	1957	2.15 ± 0.642		15.75 ± 1.866	31.58 ± 2.177
Differences in Percentage of Children Having Caries-free First Permanent Molars					
AGE GROUP	INTER-CITY		INTER-YEAR		
	YEAR	SARNIA BRANTFORD	BRANTFORD STRATFORD	YEARS	SARNIA BRANTFORD
6-8	1948 1957	5.59 S 36.96 SS	31.57 SS 3.26 NS	1948-57	2.85 NS 34.22 SS
9-11	1948 1957	-0.43 NS 32.49 SS	46.09 SS 8.51 S	1948-57	-0.20 NS 32.72 SS
12-14	1948 1957	0.99 NS 13.60 SS	31.67 SS 15.83 SS	1948-57	1.12 NS 13.73 SS
					-4.86 NS -2.11 NS

For levels of statistical significance, and discussion of standard error, see page 23.

teeth contribute most heavily to total caries experience insofar as the permanent dentition is concerned. Comparison of Tables 5 and 6 with Tables 2 and 4 will show the relative importance of the latter factor in relation to dental caries experience among children in all three cities.

The inter-year differences presented in Tables 5 and 6 show that, between 1948 and 1957, markedly significant increases occurred in the percentages of Brantford children having caries-free first permanent molars, in all three age-groups. During the same period the caries attack-rates for these specific types of teeth declined significantly. In the case of both Sarnia and Stratford children, first permanent molar caries experience remained at about the same levels in 1957 as in 1948.

Comparison of the inter-city differences between 1957 and 1948 levels shows that what has been reported concerning total caries experience of Brantford children in relation to that of both Sarnia and Stratford children applies, here, also: firstly, that a significant decrease has occurred in the numbers of carious first permanent molars among Brantford children as compared with Sarnia children; secondly, that this reduction, among Brantford children aged 6-8 years has brought caries experience down to the same low level observed among Stratford children of comparable age. More Brantford children aged 9-11 years and 12-14 years continue to experience caries attacks upon first permanent molars than is the case among Stratford children of like ages, and their caries attack-rates are still somewhat higher; the downward trend of this characteristic among Brantford children in the older age-groups, however, continues to narrow the Brantford-Stratford differences.

Upper Incisors

In regions where the water is naturally fluoridated, the permanent upper incisors of persons having lifetime exposure to such water, exhibit striking and consistently low caries attack-rates. Tables 7 and 8 summarize the findings concerning the dental caries experience in permanent upper incisor teeth, among children in the three cities under study.

In 1948 Brantford children aged 9-11 years and 12-14 years, were found to have a slightly lower caries experience as relating to permanent upper incisors, than Sarnia children of comparable ages; in comparison with Stratford children, on the other hand, Brantford children exhibited higher caries attack-rates, the differences being markedly significant.

TABLE 6

MEAN DMF (DECAYED, MISSING, FILLED) FIRST PERMANENT MOLARS PER CHILD

AGE GROUP	YEAR	Mean DMF First Permanent Molars per Child and Standard Error of Mean			
		SARNIA		BRANTFORD	STRATFORD
6-8	1948	1.55 $\pm$ 0.061		1.39 $\pm$ 0.063	0.41 $\pm$ 0.040
	1957	1.30 $\pm$ 0.064		0.39 $\pm$ 0.031	0.30 $\pm$ 0.036
9-11	1948	3.15 $\pm$ 0.051		3.26 $\pm$ 0.048	1.07 $\pm$ 0.065
	1957	3.01 $\pm$ 0.058		1.62 $\pm$ 0.062	1.24 $\pm$ 0.067
12-14	1948	3.62 $\pm$ 0.036		3.65 $\pm$ 0.033	1.76 $\pm$ 0.082
	1957	3.59 $\pm$ 0.041		2.64 $\pm$ 0.077	1.91 $\pm$ 0.074
Differences in Mean DMF First Permanent Molars Per Child					
AGE GROUP	YEAR	INTER-CITY		INTER-YEAR	
		SARNIA BRANTFORD	BRANTFORD STRATFORD	YEARS	SARNIA BRANTFORD STRATFORD
6-8	1948	-0.16 NS	-0.98 SS	1948-57	-0.11 S
	1957	-0.91 SS	-0.09 NS		
9-11	1948	0.11 NS	-2.19 SS	1948-57	0.17 NS
	1957	-1.39 SS	-0.38 SS		
12-14	1948	0.03 NS	-1.89 SS	1948-57	0.15 NS
	1957	-0.95 SS	-0.73 SS		

For levels of statistical significance, and discussion of standard error, see page 23.

TABLE 7

PERCENTAGE OF CHILDREN HAVING CARIES-FREE PERMANENT UPPER INCISORS

AGE GROUP	YEAR	Percentage of Children Having Caries-free Permanent Upper Incisors and Standard Error of Percentage			
		SARNIA		BRANTFORD	
9-11	1948	76.53 ± 1.774		82.86 ± 1.544	97.07 ± 0.807
	1957	74.22 ± 1.933		96.57 ± 0.718	98.09 ± 0.632
12-14	1948	53.91 ± 2.261		56.16 ± 2.037	95.69 ± 1.053
	1957	47.55 ± 2.209		85.56 ± 1.801	92.32 ± 1.247
Differences in Percentage of Children Having Caries-Free Permanent Upper Incisors					
AGE GROUP	INTER-CITY		INTER-YEAR		
	YEAR	SARNIA BRANTFORD	BRANTFORD STRATFORD	YEARS	SARNIA BRANTFORD STRATFORD
9-11	1948	6.33 S	14.21 SS	1948-57	-2.31 NS
	1957	22.35 SS	1.52 NS		13.71 SS
12-14	1948	2.25 NS	39.53 SS	1948-57	-6.36 S
	1957	38.01 SS	6.76 SS		29.40 SS
					1.02 NS
					-3.37 S

For levels of statistical significance, and discussion of standard error, see page 23.

TABLE 8

MEAN DMF (DECAYED, MISSING, FILLED) PERMANENT UPPER INCISORS PER CHILD

AGE GROUP	YEAR	Mean DMF Permanent Upper Incisors Per Child and Standard Error of Mean			
		SARNIA		BRANTFORD	STRATFORD
9-11	1948	0.56 ± 0.048		0.34 ± 0.034	0.01 ± 0.007
	1957	0.54 ± 0.048		0.05 ± 0.011	0.03 ± 0.012
12-14	1948	1.16 ± 0.066		1.05 ± 0.058	0.07 ± 0.020
	1957	1.25 ± 0.064		0.25 ± 0.036	0.15 ± 0.029
Differences in Mean DMF Permanent Upper Incisors Per Child					
AGE GROUP	YEAR	INTER-CITY		INTER-YEAR	
		SARNIA BRANTFORD	BRANTFORD STRATFORD	YEARS	SARNIA BRANTFORD STRATFORD
9-11	1948	-0.22 SS	-0.33 SS	1948-57	-0.29 SS 0.02 S
	1957	-0.49 SS	-0.02 NS		
12-14	1948	-0.11 NS	-0.98 SS	1948-57	-0.80 SS 0.08 S
	1957	-1.00 SS	-0.10 S		

For levels of statistical significance, and discussion of standard error, see page 23.

In 1957, Brantford children exhibited a striking decrease, both in caries prevalence and in caries attack-rates as concerning permanent upper incisors, in comparison with 1948 levels among children of comparable ages in the same city. This decrease is equally striking in comparison with Sarnia children, whose permanent upper incisor caries experience in 1957 was of the same order as was observed in 1948.

Of even greater significance, perhaps, is a comparison of the Brantford and Stratford findings. The first signs of effectiveness of controlled mechanical fluoridation of Brantford's water supply were observed in 1951, in a significant reduction in permanent upper incisor caries experience among that city's children, aged 9-11 years. At that time, however, all of the permanent upper incisor teeth in children of this age-group had been formed prior to introduction of fluoride into Brantford's water supply; in fact, in two of every three children aged 9-11 years, these teeth had erupted within two years of the start of fluoridation. The protective effect observed in 1951, whether conferred pre- or post-eruptively, must be considered to have been topical.

In 1957, the 9-11 age-group in Brantford was comprised for the first time since the outset of this study, of children whose permanent upper incisor enamel was formed subsequent to 1945, when fluoridation was begun in that city. As is shown, in Tables 7 and 8, these children exhibit the same extremely low level of caries attack upon their upper incisor teeth as do Stratford children of comparable age. In the case of the latter, 1957 levels are of the same order as those observed in 1948.

While there has been a significant improvement in the resistance to decay of these teeth among Brantford children aged 12-14 years, since 1948, the caries experience of permanent upper incisors among this group remains significantly greater than among Stratford children of like age. At the same time, the Brantford-Stratford differences, at age 12-14 years have decreased considerably in magnitude.

Deciduous Teeth

Measurement of dental caries experience in the ^{deciduous} ~~perma-~~ ~~nent~~ dentition is limited by the fact that one has no way of determining, with sufficient precision, whether a missing deciduous tooth has been prematurely lost as the result of caries attack, or has been lost due to normal physiological

TABLE 9

PERCENTAGE OF CHILDREN HAVING CARIES-FREE DECIDUOUS TEETH

AGE GROUP	YEAR	Percentage of Children Having Caries-free Deciduous Teeth and Standard Error of Percentage			
		SARNIA	BRANTFORD	STRATFORD	
6-8	1948 1957	10.16 $\pm$ 1.170 10.98 $\pm$ 1.397	12.28 $\pm$ 1.320 33.62 $\pm$ 1.559	35.64 $\pm$ 2.131 34.02 $\pm$ 2.366	
9-11	1948 1957	33.63 $\pm$ 1.977 27.15 $\pm$ 1.965	34.96 $\pm$ 1.956 38.79 $\pm$ 1.923	40.97 $\pm$ 2.366 39.36 $\pm$ 2.253	
Differences in Percentage of Children Having Caries-free Deciduous Teeth					
AGE GROUP	YEAR	INTER-CITY		INTER-YEAR	
		SARNIA BRANTFORD	BRANTFORD STRATFORD	YEARS	SARNIA BRANTFORD STRATFORD
6-8	1948 1957	2.12 NS 22.64 SS	23.36 SS 0.40 NS	1948-57	0.82 NS 21.34 SS -1.62 NS
9-11	1948 1957	1.33 NS 11.64 SS	6.01 S 0.57 NS	1948-57	-6.48 S 3.83 NS -1.61 NS

For levels of statistical significance, and discussion of standard error, see page 23.

TABLE 10

MEAN df (DECAYED, FILLED) DECIDUOUS TEETH PER CHILD

AGE GROUP	YEAR	Mean df Deciduous Teeth per Child and Standard Error of Mean			
		SARNIA	BRANTFORD	STRATFORD	
6-8	1948	4.89 $\pm$ 0.122	4.95 $\pm$ 0.134	2.20 $\pm$ 0.107	
	1957	4.94 $\pm$ 0.143	2.52 $\pm$ 0.087	2.52 $\pm$ 0.123	
9-11	1948	2.50 $\pm$ 0.111	2.37 $\pm$ 0.101	1.66 $\pm$ 0.095	
	1957	2.73 $\pm$ 0.112	1.95 $\pm$ 0.090	1.93 $\pm$ 0.103	
Differences in Mean df Deciduous Teeth per Child					
AGE GROUP	YEAR	INTER-CITY		INTER-YEAR	
		SARNIA BRANTFORD	BRANTFORD STRATFORD	YEARS	SARNIA BRANTFORD
6-8	1948	0.06 NS	-2.75 SS	1948-57	-2.43 SS
	1957	-2.42 SS	0.00 NS		
9-11	1948	-0.13 NS	-0.71 SS	1948-57	-0.42 SS
	1957	-0.78 SS	-0.02 NS		
					0.32 S
					0.27 NS

For levels of statistical significance, and discussion of standard error, see page 23.

exfoliation. At the same time, one may obtain valuable information concerning the prevalence and incidence of deciduous-tooth caries by measuring observable caries experience.

This has been done for children aged 6-8 years and 9-11 years, in Sarnia, Brantford and Stratford. The data, for 1948 and 1957, are presented in Tables 9 and 10; in terms of percentages of children having caries-free deciduous teeth, and in terms of the mean numbers of decayed and/or filled deciduous teeth per child.

Inspection of inter-city differences in 1948 shows that deciduous tooth caries experience among Brantford and Sarnia children was very similar. Higher percentages of children in Brantford had decayed/filled deciduous teeth than were found among Stratford children and their deciduous tooth caries attack-rates were significantly higher. Inter-year differences, 1948-1957, in the same city indicate that the prevalence and attack-rate of caries in deciduous teeth, among Sarnia and Stratford children have undergone but few changes, which, in the main, are non-significant. Comparison of the inter-year differences for Brantford, on the other hand, shows that caries prevalence and caries attack-rates have declined significantly between 1948 and 1957.

Improvement in the caries resistance of deciduous teeth of Brantford children is most striking when compared to the same characteristic among Sarnia children, and among Stratford children, during the period 1948 - 1957. It would appear, from inspection and analysis of these data, that fluoridation of the public water supply is a highly effective means of combatting dental caries in the deciduous dentition. In view of the widespread neglect in obtaining dental care for these teeth, the data herewith presented make a strong case for the introduction of fluoridation.

Other Effects of Fluoridation - Mottling

In a small number of cases very slight mottling, detectable only by an experienced examiner, were observed in Stratford and in Brantford. No unsightly mottling has been seen in either city during any of our surveys.

Medical Effects of Water Fluoridation

No ill effects attributable to the presence of fluoridated water have been reported by the medical profession in either Brantford or Stratford.

SUMMARY

Brantford has had more than twelve years of experience with one part per million of fluoride in its water supply. During that time a very important reduction in tooth decay has occurred, more particularly in that part of the population born there since fluoridation began, in June, 1945.

No ill effects of either a medical or a dental nature have been revealed by our study, or reported by the medical profession, by the dental profession, or by the health authorities in either Brantford or Stratford.

ACKNOWLEDGEMENTS

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Footnotes to tables:

Decrease indicated by minus sign.

Levels of statistical significance:

S Statistically significant at two standard error level;
SS Statistically significant at three standard error level;
NS Not statistically significant (p greater than 5%).

Standard error:

The standard error is a measure of the variation which is associated with the sampling process. The difference between two index values is said to be statistically significant when the probability of it arising from chance or sampling variation, i.e., rather than from one specific factor such as fluoridation, is below some agreed value. The agreed levels of statistical significance are arbitrary but are generally assumed to be the two standard error and three standard error levels. The probability of obtaining, by chance, a difference of the magnitude of two standard errors between two observed values is about 0.0445 or just below 5 per cent. The odds against such a difference occurring are, therefore, about 21 to 1. For the three standard error level, the probability is less than one per cent (0.27 per cent) and the odds are 369 to 1 against this occurrence by chance. When differences of these magnitudes are found, particularly those as great as three standard errors, we may feel quite confident in discussing them in terms of our hypothesis.

Standard errors shown have not been adjusted for finite population correction and are therefore overstated. Where no sampling was done in Sarnia and Stratford, the sampling error is, of course, zero; but the standard errors shown are used in the comparison of pairs of averages.

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